

LARVAL SUBJECTS, AUTONOMOUS SYSTEMS, AND E. COLI CHEMOTAXIS

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Upon first reading, the beginning of Chapter 2 of Difference and Repetition, with its talk of “contemplative souls” and “larval subjects,” seems something of a bizarre biological panpsychism. Actually it does defend a sort of biological panpsychism, but by defining the kind of psyche Deleuze is talking about, I’ll show here how we can remove the bizarreness from that concept. First, I will sketch Deleuze’s treatment of “larval subjects,” then show how Deleuze’s discourse can be articulated with Evan Thompson’s biologically based intervention into cognitive science, the “mind in life” or “enaction” position. Then I will then show how each in turn fits with contemporary biological work on E. coli chemotaxis (movement in response to changes in environment).

The key concept shared by all these discourses is that cognition is fundamentally biological, that it is founded in organic life. In fact and in essence, cognition is founded in metabolism. Thus fully conceptual recollection and recognition, the active intellectual relation to past and future – what Deleuze will call the dominant “image of thought” – is itself founded in metabolism as an organic process. This founding of cognition in metabolism can be read in an empirical sense, for just as a matter of fact you will not find cognition without a living organism supporting itself metabolically. But it can also be read in a transcendental sense: for our thinkers, metabolism is a new transcendental aesthetic, the a priori form of organic time and space. The essential temporal structure of any metabolism is the rhythmic production of a living present synthesizing retentions and protentions, conserved conditions and expected needs. The essential spatiality of metabolism comes from the necessity of a membrane to found the relation of an organism to its environment; there is an essential foundation of an inside and outside by the membrane, just as there is an essential foundation of past and future by the living present. We thus see the necessity of a notion of biological panpsychism: every organism has a subjective position, quite literally a “here and now” created by its metabolic founding of organic time and space; on the basis of this subjective position an evaluative sense is produced which orients the organism in relation to relevant aspects of its environment.

Let us pause for a moment to appreciate the radicality of this notion of the biological ubiquity of subjects, what we have called a “biological panpsychism.” For Deleuze in Difference and

Repetition the organism has an essential, albeit “larval,” subjectivity based in its organic syntheses, and our active intellectual syntheses are dynamically generated from this foundation. This truly radical thesis is shared by the “mind in life” position. What is most interesting is that try as they might to uphold a mechanistic position in which organisms are mere “robots,” the contemporary biologists we examine will also find themselves unable to avoid ascribing an essentially subjective position to single-celled organisms. Far from expecting them to experience the delight of a M. Jourdain discovering his predilection for prose, we might anticipate the shock – if not the downright dismay – of these scientists at learning they too share in positing a new transcendental aesthetic, an inescapable production of a singular “here and now” for each organism, and the inescapable subjective production of “sense” by that organism.

In this essay I will concentrate on the temporal aspect of this new transcendental aesthetic and on the necessary subjectivity of the organism, as these are both treated in a manageably short text, the beginning of Chapter 2 of Difference and Repetition. Although we will treat it in passing in this essay, we will not be able to reconstruct Deleuze’s treatment of the membrane and organic spatiality, as doing so would require a detour through Logic of Sense, as well as negotiating Deleuze’s relation to Gilbert Simondon’s notion of “transduction.” In the 15th Series of Logic of Sense, entitled “of singularities,” Deleuze refers approvingly to the very rich section of Simondon’s L’Individu et sa genèse physico-biologique entitled “Topologie et ontogénèse,” citing Simondon on the importance of the membrane: “the characteristic polarity of life is at the level of the membrane... At the level of the polarized membrane, internal past and external future face one another” (Deleuze 1990: 104; citing passages found at Simondon 1995: 224 and 226). And even then, once we would have laid out the Deleuze – Simondon connection, we would then have to articulate Deleuze’s notion of “sense” in Logic of Sense with the enaction school’s notion of “sense-making.” So we will defer grappling with the enormous difficulties of that full treatment and restrict ourselves to organic time and subjectivity.

DELEUZE

Deleuze’s overall aim in Difference and Repetition is to provide a “philosophy of difference,” in which identities are produced by integration of a differential field (or “resolution” of a “problematic” field; the two expressions are synonymous [Deleuze 1968 / 1994: 272 / 211]). The philosophy of difference intersects many forms of what we might call “identitarian” philosophy, from Plato and Aristotle to Kant and Hegel and others, in which identities are metaphysically primary and differences are seen within a horizon of identity. With regard to Kantian transcendental philosophy, Deleuze attempts to replace the Kantian project of providing the universal and necessary conditions for any rational experience with an account of the “genesis” (221 / 170) of “real experience [l’expérience réelle]”, that is, the “lived reality [réalité vécue] of a sub-representative domain” (95 / 69). As “sub-representative,” such “experience” is as much corporeal and spatio-temporal as it is intellectual, as much a passive undergoing as an active

undertaking. For example, the embryo experiences movements that only it can undergo (321 / 249); these movements are “pure spatio-temporal dynamisms (the lived experience [*le vécu*] of the embryo)” (277 / 215).

Deleuze provides two genetic accounts in Difference and Repetition, static and dynamic. To be fully differential, these genetic accounts must avoid a mere “tracing” of the empirical; the transcendental must be differential in order to never “resemble” empirical identities (176-77 / 135). The more well-known of the two genetic accounts is that of Chapters 4 and 5, the static genesis that “moves between the virtual and its actualization” (238 / 183). Thus instead of showing how psychological syntheses producing empirical unities are underlain by active transcendental syntheses (the categories) issued by a unified transcendental subject, Deleuze will provide a genetic account which first sets out an differential or “virtual” impersonal and pre-individual transcendental field structured by Ideas, or “multiplicities,” that is, sets of differential elements, differential relations, and singularities (236 / 182). This is the mathematical notion of differentiation, which is then coupled to the biological notion of differentiation. In this latter complementary part of static genesis, intensive spatio-temporal dynamisms incarnate the Ideas; an intensive individuation process precedes and determines the resolution or integration of the differential Idea (318 / 247). The complex notion of differentiation then is the static genetic account of real experience. Again, to reinforce the connection with the “mind in life school,” we should recall that the passive subject undergoing experience can be an embryo: “the embryo as individual and patient subject of spatio-temporal dynamisms, the larval subject” (278 / 215). Following this line of thought, by implication Deleuze must be able to account for the genesis of the real experience of a single celled organism; this will be our link to enaction and to current biological work.

ORGANIC TIME

Although a full treatment of Deleuze would require us to articulate the static and dynamic geneses, we will concentrate in this essay on dynamic genesis as establishing the a priori form of organic time and the necessary subjectivity of organic life. Chapter 2 of Difference and Repetition is devoted to Deleuze’s work on “repetition for itself.” The first step, on which we concentrate, is the discussion of the first passive synthesis of time, or habit, which produces the “living present” as the a priori form of organic time. We should note that organic time, the synthesis of habit producing the living present, is only the “foundation” of time. Deleuze’s full treatment of time in Difference and Repetition posits a second synthesis of memory producing the pure past as the “ground” of time, while the third synthesis, producing the future as eternal return of difference, we might say ungrounds and ungrounds time.

The beginning of Chapter 2 provides part of the dynamic genetic account of real experience, restricting itself, except for a brief and “ironic” remark about “rocks” (102 / 75), to the biological

register. It is “dynamic” because instead of moving from a virtual Idea to its actualization, as in static genesis, here we move from raw actuality to the virtual Idea in a series of interdependent “passive syntheses.” The first section deals with only the first passive synthesis of time, the most basic or “foundational” in this dynamic genesis. To begin his genetic account, then, Deleuze must get down to the most basic synthesis; he must show how beneath active syntheses (thought) are passive syntheses (perception) and beneath passive perceptual syntheses are passive organic syntheses (metabolism). As always, the challenge is to describe passive syntheses in differential terms, so as to avoid the “tracing” of empirical identities back to transcendental identities. So what Deleuze is trying to do is describe the differential transcendental structure of metabolism.

Part of the fabled difficulty of Difference and Repetition is Deleuze’s use of free indirect discourse in which he acts as a sort of ventriloquist for various authors (Hughes 2009). In the first section of Chapter 2, Deleuze is working with Kant, Husserl, Bergson and Hume. From Kant we have the overall framework of transcendental philosophy (albeit in the form of a genetic account of real experience) and from Husserl we have the notion of the lived or living present (le présent vécu, le présent vivant [97 / 70]), as well as the distinction of active and passive syntheses. From Hume and Bergson we get the notion of habit.

Syntheses are needed to join together a disjointed matter or sensation, since in themselves, material or sensory instants fall outside each other: “a perfect independence on the part of each presentation ... one instant does not appear unless the other has disappeared – hence the status of matter as mens momentanea” (96 / 70). Deleuze goes on to distinguish three levels of synthesis of this first level of instantaneity:

1. Instantaneous presentation and disappearance: “objectively” as matter and “subjectively” as sensation
2. Passive syntheses (contraction or habit producing a living present)
 - a. Organic syntheses (metabolism synthesizing matter)
 - b. Perceptual synthesis (imagination synthesizing sensation)
3. Active synthesis (memory as recollection and thought as representation synthesizing perceptions)

Deleuze will distinguish the organic and perceptual syntheses by showing that organic syntheses have their own form of contraction or habit.¹ For Hume and Bergson, the psychological imagination moves from past particulars to future generalities: from a series of particulars we come to expect another of the same kind. Deleuze will abstract the process of “drawing a difference from repetition” as the essence of contraction or habit and show that it occurs at the organic level as well as on the level of the passive perceptual imagination (101 / 73).

In order to isolate organic syntheses as prior to perceptual syntheses (themselves prior to active intellectualist syntheses), Deleuze radicalizes Hume and Bergson. These two “leave us at the level of sensible and perceptive syntheses” (99 / 72). But these syntheses refer back to “organic syntheses,” which are “a primary sensibility that we *are*” (99 / 73; emphasis in original). Such syntheses of the elements of “water, earth, light and air” are not merely prior to the active synthesis that would recognize or represent them, but are also “prior to their being sensed” (99 / 73). So, each organism, not only in its receptivity and perception, but in its “viscera” (that is, its metabolism), is a “sum of contractions, of retentions and expectations” (99 / 73). Here we see the organic level of the living present of retention and expectation. Organic retention is the “cellular heritage” of the organic history of life and organic expectation is the “faith” that things will repeat in the ways we are used to (99 / 73). So Deleuze has isolated a “primary vital sensibility” in which we have past and future synthesized in a living present. At this level, the future appears as need as “the organic form of expectation” and the retained past appears as “cellular heredity” (100 / 73).

Before we resume our treatment of the text, we can now briefly sketch the overall movement of the passage. Contraction or habit in organic syntheses is a “contemplative soul” in which we find an expectation that the next element of the same kind it has experienced will arrive. This temporal synthesis, a living present of expectation and retention, is the transcendental structure of metabolism. This move from experienced particular to expected general at the organic level is our “habit of life” (101 / 74). The contemplative soul as organic synthesis or habitual contraction can also be called a “passive self” or “larval subject” (107 / 78).

Now Deleuze cannot go directly to his key notion of the organic synthesis qua contemplative soul because he must first free a notion of habit from the illusions of psychology, which fetishizes activity. Psychology, by fear of introspection, misses the element of passive “contemplation.” Indeed, psychology says the self cannot contemplate itself due to fear of an infinite regress of active constituting selves.² Deleuze’s response is to pose the question of the ontological status of habit. Instead of asking how contemplation is an activity of a constituted subject, we can ask whether or not each self is a contemplation (100 / 73). How do we get to habit as what a subject is rather than what it does? First, we must determine what habit does: it draws (*soutire à*) something new from repetition: difference. Habit is essentially “contraction” (101 / 73). Now we must distinguish two genres of contraction: (1) contraction as activity in series as opposed to relaxation or dilation, and (2) contraction as fusion of succession of elements. With the second form of contraction, we come upon the notion of a “contemplative soul” which must be “attributed to the heart, the muscles, nerves and cells” (101 / 74). Deleuze knows the notion of an organic “contemplative soul” might strike his readers as a “mystical or barbarous hypothesis” (101 / 74), but he pushes on: passive organic synthesis is our “habit of life,” our expectation that life will continue. So we must attribute a “contemplative soul” to the heart, the muscles, the nerves, the cells, whose role is to contract habits. This is just extending to “habit” its full generality: habit in the organic syntheses that we are (101 / 74).

We cannot follow all the marvelous detail of Deleuze's text in which he discusses "claims and satisfactions" and even the question of pleasure, of the "beatitude of passive synthesis" (102 / 74). We have to move to the question of rhythm.

In descriptions that will be echoed by the enactivists and by the contemporary biologists we will discuss, Deleuze claims that organic syntheses operate in series, and each series has a rhythm; organisms are polyrhythmic: "the duration of an organism's present, or of its various presents, will vary according to the natural contractile range of its contemplative souls" (105 / 77). There are thousands of rhythmic periods that compose the organic being of humans: from the long periods of childhood, puberty, adulthood and menopause to monthly hormonal cycles to daily cycles (circadian rhythms) to heart beats, breathing cycles, all the way down to neural firing patterns. Everything has a period of repetition, everything is a habit, and each one of these repetitions forms a living present that synthesizes the retention of the past and the anticipation of the future as need. Now "need" can be "lack" relative to active syntheses, but "satiety" relative to organic passive syntheses. Deleuze writes: "need marks the limits of the variable present. The present extends between two eruptions of need, and coincides with the duration of a contemplation" (105 / 77).

ORGANIC SUBJECTIVITY

We now have to address a change in vocabulary, as Deleuze moves toward the notion of larval subject, which will be our link to the enactivists. First, the contemplative soul becomes the "passive self," which is "not defined simply by receptivity – that is, by means of the capacity to experience sensations – but by virtue of the contractile contemplation that constitutes the organism itself before it constitutes the sensations" (107 / 78). As we will see, we have to insist on the merely logical nature of this "before." But before that, one last vocabulary shift: the passive selves are "larval subjects." Of course we cannot just replicate whole selves all the way down the organic scale. That would just be "tracing," positing identities beneath identities. Deleuze insists: "this self, therefore, is by no means simple: it is not enough to relativize or pluralize the self, all the while retaining for it a simple attenuated form" (107 / 78). The larval subject is itself "dissolved," Deleuze will insist: "Selves are larval subjects; the world of passive syntheses constitutes the system of the self, under conditions yet to be determined, but it is the system of a dissolved self" (107 / 78).

We might think that selves merely accompany contemplation: "There is a self wherever a furtive contemplation has been established, whenever a contracting machine capable of drawing a difference from repetition functions somewhere" (107 / 78-79). But it is better to say that selves are contemplations. Contracting contemplations or habits or organic syntheses draw a difference from repetition. That is exactly what a self is: "The self does not undergo modifications, it is itself a modification – this term designating precisely the difference drawn [from repetition]"

(107 / 79). Since organic processes are serial, there is a series of such larval subjects, “Every contraction is a presumption, a claim – that is to say, it gives rise to an expectation or a right in regard to that which it contracts, and comes undone once its object escapes [se défait dès que son objet lui échappe]” (107 / 79). This undoing of the larval subject with the rhythm of fatigue and satisfaction is the key to the notion that the self is not simple, but dissolved, that is, serial and differential.

To grasp Deleuze’s notion of the organism as larval subject, everything depends on how we interpret the “priority” of organic synthesis to perceptual synthesis as different levels of passive synthesis; that is, we have to interpret the term “primary vital sensibility.” What we will learn from the enactive school is that organic and perceptual syntheses are always linked in reality. The priority of organic syntheses is merely logical, for all organisms, even the most simple, have both metabolism and sensibility, or as the enactivists will put it in a phrase that will alert Deleuzeans, “sense-making.” We will see a reinforcement of Deleuze’s merely logical “priority” of metabolism over sense-making in Ezequiel Di Paolo’s distinction between autopoiesis and adaptivity. To temporarily adopt an Aristotelian vocabulary, the enactivists will show that although we can logically distinguish between them, in reality all organisms have both a vegetative (metabolism / autopoiesis) and sensible (sense-making / adaptivity) psyche.³

The necessary combination of metabolic and perceptual capacities in an organic subject is a little difficult to see in Difference and Repetition, as Deleuze is working with the example of multicellular organisms, where metabolism and sensibility are subserved by physically distinct systems. Now even though in multicellular organisms we can spatially distinguish metabolic from sensory processes, we have to acknowledge internal monitoring, a “sensing” of the state of organism – or better, a synthesis (that is, a differentiation / integration) that establishes the trajectory of the system: where a process is going and with what acceleration. In any event, Deleuze wants to expose thousands of contemplative souls or “little selves” as thousands of organic syntheses “before” passive perceptual syntheses and active intellectual syntheses (which Kant unifies in a subject via the transcendental unity of apperception). Deleuze’s strategy is thus reminiscent of Nietzsche seeing a multiplicity of drives beneath the illusory unified ego.

But does Deleuze’s emphasis on multiplicity mean he treats the organism as an “illusion”? It all depends on how we interpret the following phrase from the Preface to Difference and Repetition. Discussing the “generalized anti-Hegelianism” that is “in the air nowadays [dans l’air du temps]” (1 / xix; translation modified), Deleuze writes: “The modern world is one of simulacra. . . . All identities are only simulated, produced as an optical ‘effect’ by the more profound game [jeu] of difference and repetition” (1 / xix). Is this Deleuze writing in his own name, setting out his thesis, or is it a report of what is in the air? Is an organism only an “illusion”? Whatever we might finally say about the unity of the organism in Difference and Repetition—although I briefly return to the issue in the Conclusion, I will defer that full reading for now—we can at least say that our task is made more difficult by the lack of an explicit discourse on the membrane, which does not appear until the following year’s Logic of Sense. Nonetheless, by the

time we reach the straightforwardly realist and materialist stance of A Thousand Plateaus, it is clear that organismic stratification is not an illusion. Strata are real (“a very important, inevitable phenomenon that is beneficial in many respects” [Deleuze 1987: 40]), and valuable (“staying stratified is not the worst thing that can happen” [161]). On the other hand, with a long enough time scale, we can see that although organisms are not illusions, they are only temporary patterns, diachronically emergent patterns unifying multiple material processes for a time. This does not prevent us from articulating Deleuze and enaction; the emphasis on synchronic emergence – on the necessary systematic functioning of metabolism – in autopoiesis as the essential structure of living things could never deny the death of individuals (Protevi 2009a).

What is radical about Deleuze’s strategy is that by following its logic, this underlying multiplicity is true for unicellular organisms as well. Deleuze pluralizes even unicellulars, both synchronically (metabolism and perception are separate processes) but also diachronically. Every iteration of a process, each case in a series of organic syntheses, is a contemplative soul, each has its own rhythm, and it is the consistency of those rhythms that allows the cell to live. Death, we can speculate, occurs when the rhythms of the processes no longer mesh. Shifting musical terms, we can say that life is harmonious music; death is disharmony. On the supra-organismic scale, death as disharmony is the condition for creativity, for the production of new forms of life, new processes.⁴ But on the organismic scale, while we can also affirm disharmony as the condition of creativity, a prudent experimentation is called for: “Dismantling the organism never meant killing yourself” (Deleuze 1987: 160).

So even though we must be literal when we say the “living present” – it occurs on the organic level “before” it occurs on the perceptual and intellectual levels – we have to remember that this priority is merely logical; in all real organisms, organic synthesis is always accompanied by perceptual syntheses. In each organism, multicellular or unicellular, the synchronic emergent unity of the organism is always an achievement, a unification of many “little selves.” But there is diachrony here as well; for Deleuze, each little self is never fully present to itself, but is “dissolved” in a series of repetitions of its process. The key is to describe this dissolved or multiple or differential biological psyche without falling into a needless projection of unified active or intellectualist synthesis onto it; that is, the key is to describe passive synthesis as a logically distinct but really linked series of multiple organic and perceptual syntheses. In doing so, we will have isolated the level of the organic “larval subject” and will have thereby defined the multiple levels of Deleuze’s “biological panpsychism.”

To summarize, then, the passive self is never fully self-present because the passive organic and perceptual syntheses upon which active syntheses are built are differential in three aspects. Each passive synthesis is serial (there is never one synthesis by itself, but always a series of contractions, each with its own rhythmic period); each series is related to other series in the same body (at the most basic level, the series of organic contractions is linked to those of perceptual contractions as these are related to those of motion: echoing the enaction school, we can say that all perception is sensorimotor); and each series is related to other series in other bodies, which

are themselves similarly differential (the series of syntheses of bodies can resonate or clash). Together the passive syntheses at all these levels form a differential transcendental field within which subject formation takes place as an integration or resolution of that field; in other words, even at this most basic level, larval subjects are the patterns of these multiple and serial syntheses which fold in on themselves (again, a full treatment of the issue would demand we articulate the role of the membrane) producing a site of lived and living experience, spatio-temporal dynamism and sentience or minimal awareness, a “primary vital sensibility.”

ENACTION

Although the emphasis on difference for Deleuze and on autonomy for the enactivists make them somewhat strange bedfellows, the notions of “primary vital sensibility” and of the “larval subject” we have just traced in Difference and Repetition can let us see some significant resonances between the two discourses with regard to organic time and organic subjectivity. For the first aspect, organic time, we will concentrate on Jonas 2003; for the second, on Di Paolo 2005; both of these are woven into the argument of Thompson 2007.

ORGANIC TIME

The enactivists straightforwardly talk of the new transcendental aesthetic we found in Deleuze as “biological time and space” (Thompson 2007: 155; citing Jonas 2003: 86). We find this expressed as a living present found in the simplest of organisms, a synthesis of retention and protention (Jonas 2003: 85-86) Furthermore, need is as rhythmic and affective for the enactivists as it is for Deleuze. Thompson writes: “concern, want, need, appetite, desire—these are essentially affective and protentional or forward-looking” (Thompson 2007: 156).

Let us turn to Jonas’s magnificent essay “Is God a Mathematician?: The Meaning of Metabolism” (Jonas 2003: 64-92) for more detail on these notions; we will see the same first steps of a dynamic genesis (from instantaneity to the living present) here as in Difference and Repetition.

Jonas proposes to test, against the case of the organism, the modern claim that God is a mathematician (65). First, Jonas reviews the history of that notion, from Plato’s Timaeus through Leibniz. What distinguishes the ancient and modern treatments of nature is the algebraic treatment of motion on the part of the moderns (67). Thus with the moderns we find “analysis of becoming” rather than “contemplation of being”; for the moderns it is process as such, rather than its perfection in an end state, that is the object of knowledge (67). This mathematical change of method, when applied to physics, means that “the functional generation of a mathematical curve becomes the mechanical generation of the path of a body” (68).

Here is the key for us, the connection with Deleuze's reaching the starting point of dynamic genesis in the *mens momentanea*" (Deleuze 1968 / 1994: 96 / 70). For Jonas, modern mathematical physics gives us time as a series of instants, such that the physical states of a process are externalized, one to the other: "each of them determined anew by the component factors operative at that very instant" (Jonas 2003: 68). Such fragmentation means that analysis meets no resistance; in other terms, there is no wholeness, only an aggregation of moments, and so ontological emergence is denied: "rationality of order ... must be explained by reference to the ... most elementary types of event ... their singleness alone is the basically real, and the 'wholeness' of their conjoint result is an appearance with no genuine ontological status" (69).

We cannot treat all the riches of the historical sections of Jonas's text, as he moves from a reading of the *Timaeus*, where the Demiurge is needed to redeem the passivity of matter (70), to modern materialism and its dualistic counterpart, idealism, a shift that results in a stunning inversion to which we have become inured: "'Matter' in fact, in the sense of 'body,' becomes more rational than 'spirit'" (73). This entails that "not only the mindless but also the lifeless has become the intelligible as such," a standard that means the moderns must understand life starting from "dead matter" (74).

Passing now to his interrogation of the purely mathematical physical analysis of metabolism (in other words, testing the reduction of biology to physics), Jonas proposes the wave as the physicist's model of complex physical form, a form that is wholly reducible to an aggregate. The wave, as an "integrated event-structure" has no ontologically emergent status; it has "no special reality is accorded that is not contained in, and deducible from, the conjoint reality of the participating, more elementary events" (77). Furthermore, Jonas, adds, what is true of the wave must be true of the organism as object of divine intellection. Without need of the "fusing summation of sense," for God, "the life process will then present itself as a series, or a web of many series, of consecutive events concerning these single, persisting units of general substance" (77). Once again, we find physical time as a pure self-exteriority, as a series of instants.

For Jonas, however, such a reductive account misses the ontological emergence that makes of life an "ontological surprise," and the organism a system, a "unity of a manifold." The organism is "whole" as "self-integrating in active performance," an "active self-integration of life" (79). The "functional identity" of organisms relative to the materials it metabolizes is constituted "in a dialectical relation of needful freedom to matter" (80; emphasis in original).

Both elements, need and freedom, constitute the "transcendence" of life, and this transcendence constitutes a living present, a metabolically founded transcendental aesthetic or a priori form of organic time: "self-concern, actuated by want, throws open ... a horizon of time ... the imminence of that future into which organic continuity is each moment about to extend by the satisfaction of that moment's want" (85). For Jonas, in a way that highlights the partiality of Deleuze's treatment in *Difference and Repetition*, organic space is founded by organic time: an organism "faces outward only because, by the necessity of its freedom, it faces forward: so that

spatial presence is lighted up as it were by temporal imminence and both merge into past fulfillment (or its negative, disappointment)” (85).

Jonas then draws the consequences for the question of the adequacy of purely mathematical physics for the phenomenon of life; in other words, he shows the necessity of a dynamic genesis from instantaneity to the living present: “with respect to the organic sphere, the external linear time-pattern of antecedent and sequent, involving the causal dominance of the past, is inadequate.” With life on the scene, “the extensive order of past and future is intensively reversed,” so that the determination of “mere externality” by the past has to be supplemented by the recognition that “life is essentially also what is going to be and just becoming” (86).

ORGANIC SUBJECTIVITY

Even with the notion of the “primary vital sensibility” of the larval subject of organic syntheses as our guiding thread, pairing Deleuze and enaction still seems odd. Developing out of the autopoiesis school founded by Humberto Maturana and Francisco Varela, the enactive position worked out by Evan Thompson in Mind in Life (Harvard, 2007) seems too focused on autonomy and identity to be usefully paired with Deleuze’s philosophy of difference. Although autopoietic theory, developed in the 1970s at the height of the molecular revolution in biology, performed an admirable service in reasserting the need to think at the level of the organism, it is clear that autopoiesis is locked into a framework which posits an identity-horizon (organizational conservation) for (structural) change. For autopoietic theory, living systems conserve their organization, which means their functioning always restores homeostasis; evolution is merely structural change against this identity horizon (Protevi 2009a). Now even if Deleuze ultimately does not think the organism is an “illusion,” when it comes to “life,” he stresses the creativity of evolution over against the conserved identity of the organism; thus for Deleuze the organism is “that which life sets against itself in order to limit itself” (Deleuze 1987: 503). Nonetheless, strictly with regard to the “primary vital sensibility” of the organism we have seen in Difference and Repetition, Deleuze and enaction can be brought together, when we follow how Thompson supplements the undoubted emphasis on identity preservation of autopoiesis with a more dynamic and differential concept of “adaptivity” drawn from the work of Ezequiel Di Paolo. With this addition, we can see the possibility of a more fruitful interchange with Deleuze.

The key is to recognize that autopoiesis entailed not just organizational maintenance, but cognition or “sense-making.” For Maturana and Varela, autonomous systems have sufficient internal complexity and feedback that “coupling” with their environment “triggers” internally-directed action. This means that only those external environmental differences capable of being sensed and made sense of by an autonomous system can be said to exist for that system, can be said to make up the world of that system (Maturana and Varela 1980: 119). The positing of a causal relation between external and internal events is only possible from the perspective of an

"observer," a system that itself must be capable of sensing and making sense of such events in its environment (81). So with autopoiesis the autonomous system is always linked to its environment and organization provides an identity horizon for structural change. But autopoiesis is only sufficient for maintenance of identity. To account for sense-making, Thompson turns to Ezequiel Di Paolo. "A distinct capacity for 'adaptivity' needs to be added to the minimal autopoietic organization so that the system can actively regulate itself with respect to its conditions of viability and thereby modify its milieu according to the internal norms of its activity" (Thompson 2007: 148).

With this important connection in mind, we can move to consider sense-making. Witness the single-celled organism's ability to make sense. "Sense" has, perhaps fittingly, a three-fold sense: sensibility, signification, and direction.⁵ A single-celled organism can sense food gradients (it possesses sensibility as openness to the environment), can make sense of this difference in terms of its own needs (it can establish the signification "good" or "bad"), and can turn itself in the right sense for addressing its needs (it orients itself in the right direction of movement). This fundamental biological property of affective cognition is one reason why the Cartesian distinction of mental and material has no purchase in discussions of sense-making. There is no "mental" property (in the sense of full-blown reflective consciousness) attributable to the single-celled organism, but since there is spontaneous and autonomous sense-making, there is no purely "material" realm either in these organisms either. The enactive claim is that affective cognition in humans is simply a development of this basic biological capacity of sense-making.

Turning now to Di Paolo's essay, we see that he distinguishes within Maturana and Varela's work the all-or-nothing character of organizational maintenance from a more dynamic notion of homeostatic regulation. "Whereas homeostasis connotes the existence of active mechanisms capable of managing and controlling the network of processes that construct the organism, conservation is a set-theoretic condition that may or may not be realized in an active manner. It merely distinguishes between changes of state without loss of organization and disintegrative changes" (Di Paolo 2005: 435).

For Di Paolo, organizational conservation cannot explain organismic sense-making – directed action responding to environmental change relevant for the organism – precisely because it is all-or-nothing: "But what makes bacteria *swim up* the gradient? What makes *them* distinguish and prefer higher sugar concentrations? As defined, structural coupling is a conservative, not an improving process; it admits no possible gradation" (437). Di Paolo insists that an organism's sense-making, its judgment as to the improvement of conditions relative to its need, is beyond the scope of autopoiesis: "Even if the current rate of nutrient intake is lower than the rate of consumption (leading to certain loss of autopoiesis in the near future), bacteria will not seek higher concentrations *just because* they are autopoietic since improving the conditions of self-production is not part of the definition of autopoiesis" (437).

The key for us is to see that adaptivity requires a dynamic emergent self unifying a multiplicity of serial processes. We might say that autopoiesis entails synchronic emergence, whereas adaptivity entails diachronic emergence. Notice the dynamic monitoring of multiple processes Di Paolo isolates here as necessary for generating singular norms of each organism: “Only if they are able to monitor and regulate their internal processes so that they can generate the necessary responses anticipating internal tendencies will they also be able to appreciate graded differences between otherwise equally viable states. Bacteria possessing this capability will be able to generate a normativity *within* their current set of viability conditions and *for themselves*. They will be capable of appreciating not just sugar as nutritive, but the direction where the concentration grows as useful, and swimming in that direction as the right thing to do in some circumstances” (437).

Adaptive mechanisms (the measurement of the trajectory of the system against a norm and the regulative means of bringing deviations back to that norm – or indeed of changing the norm itself) are serial and so the emergent self of the organism is in Deleuze’s terms a “system of a dissolved self” (Deleuze 1968 / 1994: 107 / 78). In general, we have to stress the “systematic” nature here to see the connection of Deleuze with adaptivity, but the dissolution of serial selves is clear when Di Paolo writes: “The operation of single adaptive mechanisms is in normal circumstances self-extinguishing but their interaction, the ongoing coupling with the environment, and the precariousness of metabolism, make their collective action also self-renewing, thus naturally resulting in *valenced rhythms of tension and satisfaction*” (444-445; emphasis in original).

So, we might want to relate the “simple self” of Deleuze to the all-or-nothing character of autopoiesis, and the “system of a dissolved self” to the dynamic character of adaptivity. That is, in adaptivity there is a measuring of the trajectory of the organism against norms (“anticipating internal tendencies”). In order for it to be the continual monitoring and regulation of an ongoing organism in its life span, that measurement has to be serial, that is, rhythmic, dynamic and constantly renewable (“self-extinguishing”). It cannot just be abstract “structural change” over against “organizational maintenance.” Deleuze is going to call each snapshot of a dynamic series of modifications, each “drawing of a difference from repetition,” the “larval subject.” The seriality of such a subject is indicated by the fact that the self “comes undone [*se défait*] once its object escapes” (Deleuze 1969 / 1994: 107 / 79); this is the “self-extinguishing” of a “single adaptive mechanism” for Di Paolo.

E. COLI CHEMOTAXIS

We have brought Deleuze and enaction together, at least from a certain perspective. But what if neither discourse relates to contemporary biology? To ground the discussion, we will look at the description of organic and perceptual syntheses in E. coli chemotaxis, a favorite example of

sense-making for the enactivist school, in two recent biology works, Howard Berg's E. Coli in Motion (2004) and Dennis Bray's Wetware (2009). We will look at two aspects of their work to make the connection with Deleuze and with enaction. First, their account of synthesis as differentiation- integration, as "drawing a difference from repetition," that is, their establishment of a transcendental aesthetic for organic life, the living present as retention and protention, a constantly renewed "here and now." Second, their fear of organic subjectivity coupled with their inability to forego first-person evaluative language.

ORGANIC TIME

We will find here the Deleuzean notion of passive synthesis as constituting the living present. Our authors stress the temporality of perception for their objects of study. Bray stresses the retentive aspect of E. coli, who "continually reassess their situation" by means of "a sort of *short-term memory*" (Bray 2004: 7; emphasis in original). Such "bacterial memory" can be tested by exposing them to a step change in the concentration of an attractant: "Now it is clear that what the bugs respond to is not the concentration of aspartate per se but its rate of change" (94). Bray interprets these results in terms that cannot fail to delight any reader of Deleuze. "But once aspartate has settled down to a steady concentration, the bug no longer responds. Biologists call this adaptation, but a mathematician examining the time course of response would call it differentiation. By measuring the rate of change in the signal, the receptor cluster has in effect performed calculus!" (94). In other words, the bacterium has repeated its measurement of aspartate and drawn a difference from that repetition: it has performed a differentiation.

But the living present is a synthesis of retention and protention. Berg's work on temporal synthesis reveals the protention aspect, as well as the insightful character of Deleuze's treatment of contractile habit as "drawing a difference from a repetition." Berg first clearly shows retention as one aspect of the passive synthesis of the living present: "to correct its course, the cell must deal with the recent past, not the distant past" (Berg 2004: 57). But then we see that the living present is serial, that it draws a difference from a repetition; Berg writes that "to determine whether the concentration is going up or down, the cell has to make two such measurements and take the difference" (57). Berg shows that this perceptual synthesis is temporal rather than spatial; describing the results of a key experiment, he writes: "the response to the positive temporal gradient was large enough to account for the results obtained in spatial gradients" (36). So the cell repeats its sampling procedure (it analyzes the environment, breaking it down to identify the concentration of molecules of interest) and then synthesizes the two results. What we see here in this passive synthesis is differentiation (calculation of the instantaneous rate of change of a gradient) and integration (calculating the trajectory of the change by combining the results of previous differentiations). We thus have sense-making in the living present: retention (of past differentiations) and protention (the integrated trajectory as indicating the future course of the organism).

In further confirmation of the Deleuzian and enactivist treatments of the living present, these passive syntheses are rhythmic. Due to its being buffeted by the Brownian motion of water molecules, after about 10 seconds, an *E. coli* cell “drifts off course by more than 90 degrees, and thus forgets where it is going” (49). The living present has limits to its retention; it has an essential “forgetting.” Continuing with his analysis, Berg writes: “This sets an upper limit on the time available for a cell to decide whether life is getting better or worse. If it cannot decide within about 10 seconds, it is too late” (49-50). Just as it has an upper limit to its living present, “a lower limit is set by the time required for the cell to count enough molecules of attractant or repellent to determine their concentrations with adequate precision” (50). More precisely, “diffusion of attractants or repellents sets a lower limit on the distance (and thus the time) that a cell must swim to outrun diffusion (to reach greener pastures), as well as on the precision with which the cell, in a given time, can determine concentrations” (56). As Berg puts it: “if it is to go far enough to find out whether life is getting better or worse, it must outrun diffusion” (56). This minimal time for perceptual synthesis is 1 second, “approximately equal to the mean run length” (56). With Berg’s analyses of *E. coli* chemotaxis, we see here a constantly renewed living present, the constitution of a singular “here and now” for each bacterium.

ORGANIC SUBJECTIVITY

In his Preface Bray writes that he received a rejection note from another publisher accusing him of writing a book about “single-celled organisms possessing consciousness” (Bray 2009: ix). Bray reacts indignantly, but we will see that he protests too much in writing that “single cells are not sentient or aware in the same way that we are. To me, consciousness implies intelligent awareness of self and the ability to experience introspectively accessible mental states. No single-celled organism or individual cell from a plant or animal has these properties” (ix). No one, least of all Deleuze and the enactivists, would complain of this perfectly defensible high bar to meet for the ascription of “consciousness.” But Bray has thrown “sentience” and “awareness” in too quickly with “consciousness,” as we can see when he calls *E. coli* “robots.” Bray writes that “An individual cell, in my view, is a system that possesses the basic ingredients of life but lacks sentience. It is a robot made of biological materials” (Bray 2009: ix). The “robot” as line of defense against accusations of biological panpsychism is repeated by Howard Berg, who also writes, regarding his “top down, or outside in” treatment of cell populations, that from this perspective, *E. coli* should be seen as “robots programmed to respond to external stimuli” (Berg 2004: 19).

To avoid the charge of a too easy ascription of micro-subjectivity, Bray takes a strong computationalist and representationalist stance. “It is as though each organism builds an image of the world—a description expressed . . . in the language of chemistry” (Bray 2009: x). The most intense locus of this representation is found in the genome and protein synthesis: “From a time-compressed view, the sequences and structures of RNA, DNA, and proteins can be thought of as

continually morphing in response to the fluctuating world around them” (x). Thus we come to the “central thesis of the book—that living cells perform computations” (xi). So, to avoid any hint of biological panpsychism, for Bray, cells are non-sentient robots.

Once we enter the book however we find Bray bothered about mechanism missing something. “Like manic pathologists at an autopsy competition, we have littered our workbenches with the dissected viscera of cells... But where in this museum of parts do we find sensation, volition, or awareness? Which insensate substances come together, and in what sequence, to produce sentient behavior?” (5). However, Bray soon returns to his computationalist position: “The molecular mechanism of *E. coli* chemotaxis is a superb illustration of cellular information processing” (6). But he cannot sustain the mechanistic position. Due to Brownian motion from buffeting by water molecules, “to pursue any direction for more than a second or so, bacteria have to constantly reassess their situation” (7). But, if it is their situation, they must have a proper point of view. It is not just “the” situation, but “their” situation. We can call see here the instability of this discourse, its shifting from third to first-person perspective.

In his discussion of the mechanism of that reassessment, Bray is worried about subjectivity. “Words like *memory*, *awareness*, and *information* are easy to use but require careful definition to avoid misunderstanding. I’m using *short-term memory* here in a colloquial, nonspecialist way, referring to how a swimming bacterium carries with it an impression of selected features of its surroundings encountered in the past few seconds” (7; emphasis in original). But despite these qualifications, he has to return to the first-person perspective. Adding aspartate to a solution will take the percentage of tumbling cells from 20% to near zero. This is because “the cells have experienced an improvement in their environment (a taste of food) and consequently persist in their current direction of swimming” (7). “Experienced” here shows the inevitability of some notion of minimal subjectivity.

We see the same instability of discursive stances in Howard Berg. He first seems to indicate the necessity of a first-person perspective in his distinction between “aesthetics” and “material gain.” He writes that the modern era of *E. coli* research begins in the 1960s when “Julius Adler demonstrated that *E. coli* has a sense of taste, that is, that bacterial chemotaxis is a matter of aesthetics rather than material gain” (Berg 2004: 15). In discussing such sampling, though, Berg reverts to a third-person perspective: “Adler was able to show that *E. coli* responds to chemicals that it can neither transport (take up from surrounding medium) nor metabolize (utilize as a source of energy or raw material)” (24). Another example is perhaps more telling. Berg writes of “attractants” and “repellants,” which seemingly imply a first-person perspective; but he defines them in purely third-person behavioral terms: “chemicals whose gradients strongly affect the motile behavior of wild-type *E. coli*” (25; Table 3.1).

Much as they try however, in the long run the authors cannot avoid a blend of third-person mechanism and first-person evaluation. Bray writes of how *E. coli* possesses “a sort of short-term memory that tells them whether conditions are better at this instant of time than a few

seconds ago. By ‘better’ I mean richer in food molecules, more suitable in acidity and salt concentration, closer to an optimum temperature” (Bray 2009: 7). The seemingly innocuous term “food” is the give-away, for “food” is a relational term: sucrose is only food “for” an organism; it is not food in itself (Thompson 2007: 158). And clearly “suitable” and “optimum” are relative to the life process of organisms.

A final example from Bray, linking retention in the living present to subjective evaluation: “Bacteria store a running record of the attractants they encounter. This tells them whether things are better or worse: whether the quantity of food molecules in their vicinity is higher or lower than it was a few seconds ago” (Bray 2009: 94). Here again we see the mixture of mechanistic (third person) and evaluative (first person) language. If a “quantity” of (chemical) “molecules” is being measured, we have a third person description of a mechanism, but if it is “food” being measured, we have a first person perspective; the measurement of food is relative to the need of an organism. The inevitability of first-person evaluative terms is clear soon when Bray writes: “It’s a pragmatic strategy: if conditions are improving, continue swimming; if not, tumble and try another direction” (94).

Let us conclude this all-too-brief discussion of the treatment of organic subjectivity in contemporary biology by returning to Berg, who is somewhat more straightforward in his adoption of evaluative terms and a first-person perspective. In discussing the run versus tumble behavior of individual cells, Berg writes that “E. coli extends runs that are favorable (that carry cells up the gradient of an attractant) but fails to shorten runs that are not (that carry cells down such a gradient.... Thus, if life gets better, E. coli swims farther on the current leg of its track and enjoys it more. If life gets worse, it just relaxes back to its normal mode of operation. E. coli is an optimist” (Berg 2004: 35).

CONCLUSION

We cannot exaggerate the fit of enaction and Deleuze. We have stressed the serial, dynamic, affective and differential character of enaction, but we have underplayed some of Deleuze’s radicality.

To have a full picture of the notion of organism in Difference and Repetition, we would have to discuss it in terms of static genesis, for the organism is one of the prime examples of Ideas, first discussed in terms of Geoffrey Saint-Hilaire and anatomical elements and then updated in terms of genetics (Deleuze 1968 / 1994: 239-40 / 184-185). But Ideas are incarnated by spatio-temporal dynamisms, which are processes of individuation, so a confrontation with Deleuze’s reading of Simondon will be necessary (317 / 246). The larval subject is the individual in the process of individuation and hence tied to a metastable field in an ongoing process of “transduction.” The priority of individuation over differentiation must be respected (318 / 247) and this leads Deleuze to a prescient critique of genetic determinism: “The nucleus and the genes

designate only the differentiated matter – in other words, the differential relations which constitute the pre-individual field to be actualized; but their actualization is determined only by the cytoplasm, with its gradients and its fields of individuation” (323 / 251).⁶

Even on the basis of this brief sketch, it might appear then that the emphasis in enaction on the notion of autonomous system overemphasizes the individual as self-conserving product as opposed to individuation as always ongoing process. From this perspective, the embryo as paradigmatic “larval subject” is merely a more intense site of individuation than the adult; however sclerotic and habitual, the adult is only the limit of the process of individuation; it is never actually reached; no more than the virtual does the actual exist, rather than insist. In terms of autopoietic synchronic emergence, then, we might say that enaction relegates the metastable field to coupled environment and limits transduction to metabolism, while in terms of adaptivity’s diachronic emergence, it neglects ontogenesis in favor of adult function and restricts transduction to homeostatic regulation. I am under no illusions as to my capacity at the present time to prove these assertions; I merely wish to record them as speculations to be pursued in future work.

Finally, we should note that by radicalizing what we might call the Bergsonian and Whiteheadian threads, which intersect the Simondonian thread, we can see a total panpsychism in Difference and Repetition that surpasses the biological. Deleuze notes that the mathematical and biological notions of differentiation and differentiation employed in the book are only a “technical model” (285 / 220). Now if “the entire world is an egg” (279 / 216), then every individuation is “embryonic” we might say, even “rocks” (282 / 219) and “islands” (283 / 219). Now if rocks and islands as individuation processes are embryonic, then they too have a psyche: “every spatio-temporal dynamism is accompanied by the emergence of an elementary consciousness” (284 / 220). We will not pursue this line of thought, but will note that by the time of *Anti-Oedipus* (Welchman 2009) and *A Thousand Plateaus* (Bonta and Protevi 2004; Protevi 2009b) Deleuze and Guattari explicitly thematize that the syntheses are fully material syntheses, syntheses of nature in geological as well as biological, social, and psychological registers. With this full naturalization of syntheses, the question of panpsychism is brought into full relief, as syntheses of things simply are syntheses of experience.

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NOTES

¹ The major commenters on Difference and Repetition – Hughes 2009; Bryant 2008; Beistegui 2004; Williams 2003 – do not isolate the level of organic synthesis. The exceptions are Ansell-Pearson 1999 and De Landa 2002.

² For a treatment of the infinite regress problem in philosophical psychology, see Zahavi 2005.

³ Of course, Aristotle himself thought that plants possessed only the nutritive or vegetative psyche and that only animals had a sensible psyche. For an interesting take on the Aristotelian resonances here in the context of contemporary philosophy of mind and cognitive science, see Wheeler 1997.

⁴ We cannot treat the very rich discussion of the double aspect of death in Difference and Repetition, but we are here alluding to the way Deleuze reads the “death instinct” as “an internal power which frees the individuating elements from the form of the I or the matter of the self in which they are imprisoned.... the liberation and swarming of little differences in intensity” (Deleuze 1969 / 1994: 333 / 259)

⁵ There is an archaic sense of the English word "sense" meaning "direction," as in "the sense of the river." This sense is still present in French, as in, among other uses, the expression sens unique for "one-way street." I have treated the three-fold “sense of sense” in Protevi 1990 and 1998.

⁶ For contemporary critiques of genetic determinism, see the “Developmental Systems Theory” school of thought, whose founding document is Oyama 2000; see also Oyama, Griffiths, and Gray 2001.